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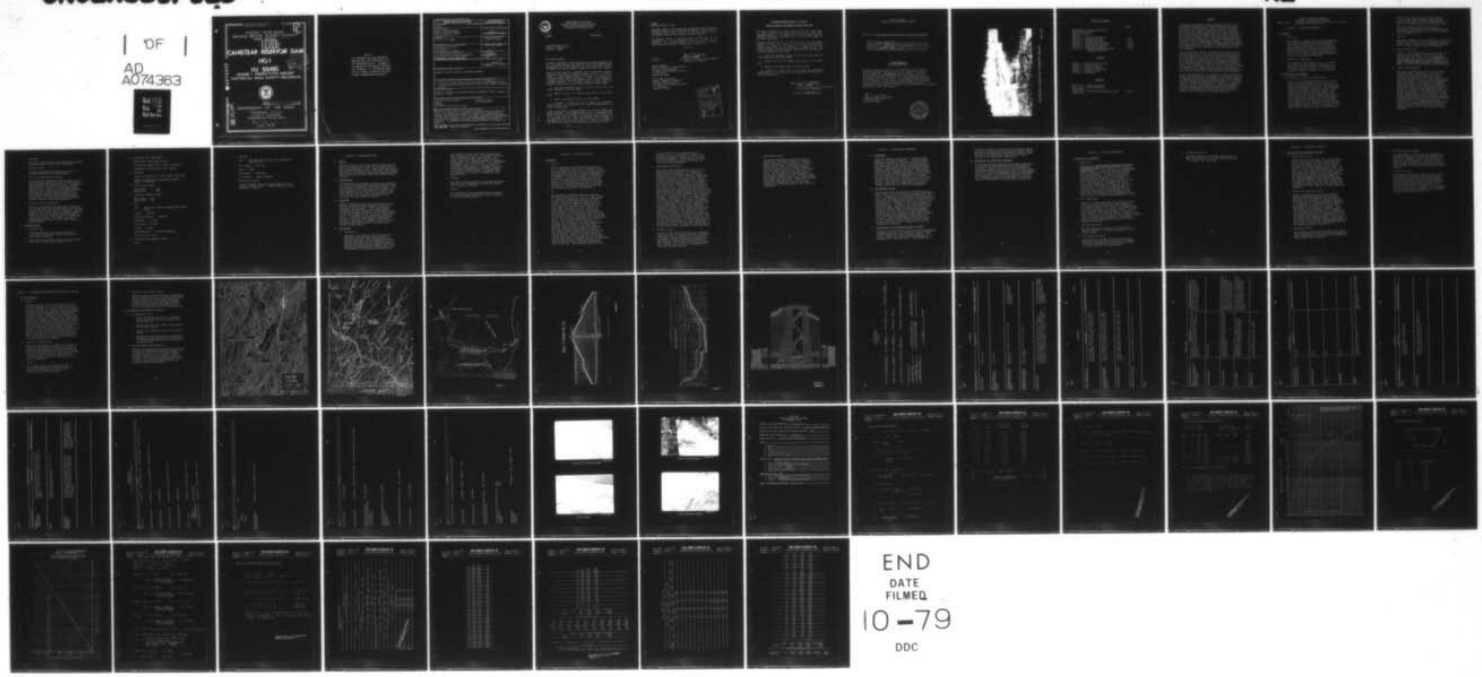

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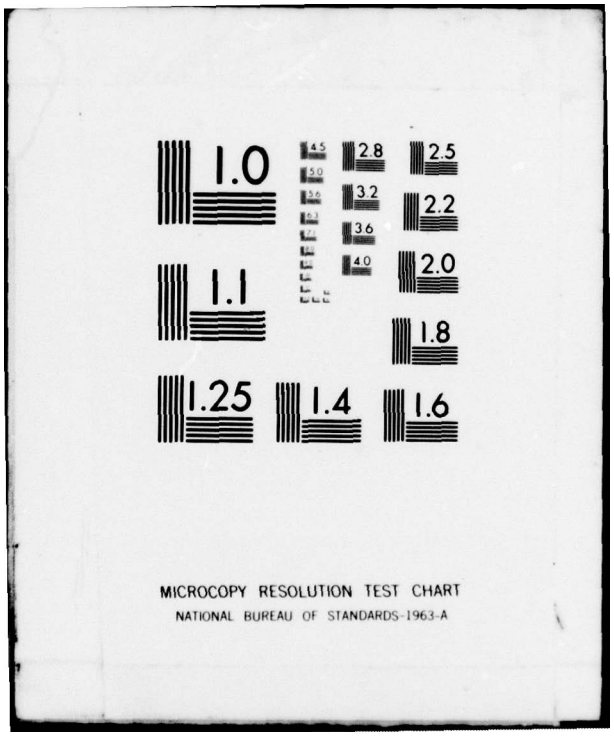
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PASSAIC RIVER BASIN
PACACK BROOK, SUSSEX COUNTY
NEW JERSEY

LEVEL

CANISTEAR RESERVOIR DAM

NO 1

NJ 00485

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

DEPARTMENT OF THE ARMY

Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

June, 1979

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NJ00485	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): Phase I Inspection Report National Dam Safety Program Canister Reservoir Dam No.1 Sussex County, N.J.	5. TYPE OF REPORT & PERIOD COVERED: FINAL rept.
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7. AUTHOR(s): Jolls, F. Keith [illegible] / Jolls	8. CONTRACT OR GRANT NUMBER(s): DACW61-79-C-0011
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Louis Berger & Associates 100 Halstead St. East Orange, N.J. 07019	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 12 62p.
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Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) Number 1

National Dam Safety Program. Canister Reservoir Dam (NJ-00485), Passaic River Basin, Pacack Brook, Sussex County, New Jersey. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Canister Reservoir Dam No. 1
Riprap
Spillways
National Dam Inspection Act report
Structural Analysis
Visual inspection

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

17 SEP 1979

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Canistear Reservoir Dam No. 1 in Sussex County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Canistear Reservoir Dam No. 1, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in good overall condition and the dam's spillway is considered adequate. The following remedial actions should be completed within one year from the date of approval of this report:

a. Clean the downstream outlet of displaced riprap stone and replace same above the outlet headwall.

b. Repoint and reset all exposed stone masonry in the outlet walls.

c. Replace the antiquated valves in the gate chamber.

d. Continue to monitor and record seepage and groundwater characteristics in the vicinity of the abutment backslopes and the outlet retaining walls.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman James A. Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

NAPEN-D
Honorable Brendan T. Byrne

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JOEL T. CALLAHAN
Lieutenant Colonel, Corps of Engineers
Acting District Engineer

1 Incl
As stated

Copies furnished:
Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

CANISTEAR RESERVOIR DAM NO. 1 (NJ00485)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 10 May 1979 by Louis Berger & Associates, Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Canistear Reservoir Dam No. 1, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in good overall condition and the dam's spillway is considered adequate. The following remedial actions should be completed within one year from the date of approval of this report:

a. Clean the downstream outlet of displaced riprap stone and replace same above the outlet headwall.

b. Repoint and reset all exposed stone masonry in the outlet walls.

c. Replace the antiquated valves in the gate chamber.

d. Continue to monitor and record seepage and groundwater characteristics in the vicinity of the abutment backslopes and the outlet retaining walls.

APPROVED: Joel Callahan

JOEL T. CALLAHAN
Lieutenant Colonel, Corps of Engineers
Acting District Engineer

DATE: 13 September 1979

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam Canistear Reservoir Dam No. 1 Fed ID # NJ 00485

State Located New Jersey
County Located Sussex
Coordinates Lat. 4106.7 - Long. 7429.5
Stream Pacock Brook
Date of Inspection 10 May 1979

ASSESSMENT OF GENERAL CONDITIONS

Canistear Reservoir Dam No. 1 is assessed to be in a good overall structural condition and it is recommended that it be downgraded to a significant hazard category. No detrimental findings were uncovered to merit further study as the spillway at the nearby Dam No. 2 has sufficient capacity to discharge the design flood. Recommended remedial actions to be undertaken in the future include removing the displaced riprap stone in the outlet channel and rebedding on the downstream slope; repoint the outlet structure masonry and replace the valves in the gate chamber.

F. Keith Jolls P.E.
Project Manager

OVERVIEW OF CANISTEAR RESERVOIR DAM NO. 1

MAY, 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: Canistear Reservoir Dam No. 1, FED ID# NJ 00485

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Corps of Engineers, Philadelphia to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of Canistear Reservoir Dam No. 1 and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Dam No. 1 at Canistear Reservoir is a 680 foot long, earth-fill structure (crest el. 1092) with a concrete corewall cutoff extending from elevation 1089 down to bedrock. The embankment, whose crest width is 18 feet, has 2H:1V slopes which are entirely covered by riprap. Both slopes have a berm at elevation 1067. The reservoir berm is 16 feet wide and protected with riprap while the downstream slope berm is 12 feet wide with no riprap. The outlet works are located 537 feet from the right abutment and consists of 9' x 11' masonry inlet and outlet tunnels, two 42" diameter, cast iron drain pipes which constrict to 30" in diameter at the gate valves. There are four 30" gate valves

(two on each pipe) housed in a deep masonry 11' x 11' gate house chamber which extends from the dam crest to invert elevation 1035.5. Access is provided from the top by steel stairs.

This dam, together with Overflow Dam No. 2 (reported on separately) form the major containment structures for the City of Newark reservoir (see Paragraph 1.2.f.).

b. Location

The dam is located at the southern end of Canistear Reservoir on Pacack Brook in Hardyston Township, Sussex County, about 2 miles upstream (northeast) of N.J. Route 23 and the town of Stockholm.

c. Size Classification

Dam No. 1 has a maximum height of 70± feet and a maximum storage capacity of 9315 acre feet. Accordingly, this dam is in the intermediate size category as defined by the criteria in the Recommended Guidelines for Safety Inspection of Dams. (Maximum storage between 1,000 and 50,000 acre feet, and a height between 40 and 100 feet).

d. Hazard Classification

The dam is located within the City of Newark Watershed which, downstream of the dam, is uninhabited and undeveloped as far as the village of Stockholm at Route 23. About a mile upstream from Route 23, Pacock Brook enters the flat, swampy, floodplain of the Pequannock River. Development in Stockholm is generally located 20 feet or more above the floodplain and would suffer little damage from a dam break flood wave. However, the Pequannock River channel is severely constricted 3000 feet downstream of Stockholm. This constriction could create a backwater which could result in significant damage to homes and businesses along the floodplain and Route 23 as well as the embankment of the Susquehanna and Western Railroad. Accordingly, it is recommended that this dam be placed in the significant hazard category (the same as Dam No. 2) as in the opinion of the inspection team, none of the above are highly hazardous.

e. Ownership

This dam is owned by the City of Newark, Division of Water Supply, Little Falls, New Jersey.

f. Purpose of Dam

This dam was constructed solely for use as a storage impoundment for water supply.

g. Design and Construction History

Both dams were designed in 1896 in order to form a water supply impoundment for the East Jersey Water Company, the original owners. Construction appears to have followed the original design quite closely. There are no microfilm records available at the NJDEP regarding Dam Application files, design considerations or details of construction. Recent refurbishments include new entrance doors for the gate valve chamber as well as a 10' high cyclone fence around the chamber entrance to prevent vandalism.

h. Normal Operating Procedures

The dam is maintained and operated by personnel of the City Division of Water Supply, who perform routine security patrols and inspection. During periods of low flows, water is released from this reservoir via the low level drains to augment flows into the Oak Ridge Reservoir, located some 3 miles downstream. The normal overflow is discharged over Dam No. 2 which also feeds the same reservoir.

1.3 PERTINENT DATA

a. Drainage Area

Canistear Reservoir has a drainage area of 5.32 square miles which consist primarily of undeveloped woodlands.

b. Total combined spillway capacity at maximum pool elevation - 12,345 cfs (at Dam No. 2).

c. Elevations (ft. above MSL)

Top of dam - 1092 (Dams 1 and 2)

Principal spillway crest - 1086 (at Dam No. 2)

Streambed at centerline of dam - 1035 ±

d. Reservoir

Length of maximum pool (top of dam) - 9400 feet

Length of normal pool (principal spillway crest) - 9,000 feet

e. Storage (acre-feet)

Top of dam - 9315
Normal pool - 7400

f. Reservoir Surface (acres)

Top of dam - 336
Normal pool - 302

g. Dam

Type - Earth with concrete corewall and riprap faces

Length - 680 feet

Structural Height - 70± feet

Top Width - 18 feet

Side Slopes - 2 H:1V

Zoning - Unknown

Impervious Core - concrete corewall

Grout curtain - None

h. Diversion and Regulating Tunnel

None

i. Spillway

Type - Straight drop overflow weir located at Dam Site No. 2.

Weir Length - 280 feet

Gates - None

U/S Channel - Reservoir

D/S Channel - Natural channel

j. Regulating Outlets

Two 42" diameter cast iron pipes tapering to 30" diameter at gate valves. Entrance and exit invert elevation = 1035.5.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

General details of the initial design were obtained from two drawings of the dam and its appurtenances which were prepared in 1896. While the design report and attendant parameters are unavailable, the details depicted on the available plans and sections indicate that the dam and its facilities were conservatively designed.

2.2 CONSTRUCTION

No information is available regarding the construction of the dam although field reconnaisance reveals construction followed the plans quite closely. The one exception is the crest elevation to which the riprap protection on both slopes is carried. The plans indicate the top limit to be at crest elevation whereas it is actually constructed to an elevation two feet below the crest.

2.3 OPERATION

General information pertaining to operational procedures was obtained from personnel of the City Division of Water Supply. Formal operational procedures for the entire water supply system, including Canistear Reservoir, is available at the Little Falls Office of the Division of Water Supply but are not germane to the inspection contained herein. Since Canistear Reservoir functions primarily as a back-up water supply to Oak Ridge Reservoir, operation is limited to control of the reservoir level and released into Pacock Brook depending upon demand.

2.4 EVALUATION

a. Availability

Sufficient data was obtained to assess the hydrologic and hydraulic capacity of the reservoir and dam. While the specific engineering properties of the embankment fill are unknown, the fact that this dam has stood as designed for over 80 years suggest that a high degree of conservatism was carried over into the embankment requirements and compaction.

The concrete corewall was keyed into the bedrock as shown in Figure 3. The bedrock consists of the Pre-Cambrian-age Losee gneiss. The Losee gneiss is a hard, white granitoid rock which, along with the Byron gneiss, is considered a "basement" rock in New Jersey. This durable, metamorphic rock, with only a thin layer of overlying ground moraine, is thought to provide an excellent foundation for the dam although no records of core borings, or fracture zones were available to assess the foundation rock permeability.

b. Adequacy

The original design plans and sections available are felt to be adequate to evaluate the structural aspects of the dam.

c. Validity

The validity of the engineering data available is not challenged and accepted without recourse to further investigations.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspection of Canistear Reservoir Dam No. 1 took place on May 10, 16, 1979 with engineering personnel of the City of Newark, Division of Water Supply and the New Jersey Department of Environmental Protection, Bureau of Floodplain Management. Structural details of the dam and its present condition were discussed with the owner's representatives who described various aspects of their operation as well as localized problems and remedial measures that have been undertaken. The overall condition of the dam was considered generally satisfactory.

b. Dam

The embankment grades smoothly into bedrock abutments at both ends of the dam. Both slopes are covered by large-size, stone riprap which is generally distributed uniformly on both slopes. Minor settlement or slumping of the stone has occurred along the crest on the upstream face of the dam but this appears to have stabilized some time ago. All of the large stone is missing from a 17-foot wide swath between the berm and the top of the outlet structure on the downstream slope of the dam. The missing riprap is displaced into the bottom of the outlet channel approximately eighteen feet below. This is apparently the result of vandalism. The left end of the dam crest is utilized as a roadway by the Water Department personnel when working at the gate house. However, tracks extend to the right abutment. Near the left end, approximately 75 feet of dam crest appears to have minor settlement but the riprap armor prevents any major erosion from occurring. There are several small evergreens growing along the crest and on the downstream slope berm. Groundwater was noted emanating from several locations beyond the toe in the heavily wooded area at the right downstream side of the dam. Some dampness was also noted

at the juncture of the embankment and abutment but it is uncertain if this is the result of seepage or surface runoff in the intersecting swale. Light erosion was noted at several locations, primarily behind the outlet structures endwalls.

c. Appurtenant Structures

The design plans indicate that the 9' x 11' inlet and outlet aqueducts are identical in design with the exception of a trash gate positioned on the intake entrance. While the intake could not be seen, the outlet structure exhibits signs of its advanced age. Mortar between the dimension masonry of the wingwalls is crumbling and several blocks on the head walls are loose. Efflorescence was noted over the entire face of the structure and, within the culvert, heavy carbonate precipitation has formed miniature stalactites on the ceiling arch. Heavy seepage was noted dripping from the ceiling and sides of the tunnels and the left wingwall was wet to within five feet of its top near the headwall. Dampness on the left wingwall was limited to the bottom 3 feet near the headwall. The combination concrete, stop-log bracket and sill located near the end of the wingwalls has badly deteriorated. The outlet channel is filled with debris which consists primarily of displaced riprap and small stone although some bank erosion products are deposited at the mouth of the outlet. The gate house structure appears in satisfactory condition and new doors and landings have been installed recently. One of the four gate valves is inoperative due to a missing stem and wheel. While the three remaining valves can be operated, their adjustment has become so stiff, it requires several men to operate each wheel, according to City Engineers.

d. Reservoir Area

As part of the Newark Watershed, the immediate reservoir area is protected against surrounding development and is composed of first-growth woodlands. Bedrock outcrops are common along the shoreline which rises abruptly from the lake surface. The terrain is relatively steep and irregular due in part to the bedrock outcrops and glacial scouring.

e. Downstream Channel

The channel immediately below the outlet is cluttered with riprap and debris. However, beyond the end of the structure, the narrow stone-lined channel is relatively free of constrictions. The steep, narrow channel gradually broadens into a flatter flood plain. Since the main outlet of the reservoir is at Dam 2, the only flow this channel carries results from seepage and valve leakage or the occassional releases from the low level drains. The channel joins the main Pacack Brook channel about 1000 feet downstream. There is no development between the dam and the flood-plains of the Pequannock River (about one mile downstream).

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Canistear Reservoir functions as a back-up water supply for Oak Ridge Reservoir. As such, routine operations consist of continuous monitoring the reservoir water level; repair, and maintenance of the regulating appurtenances; and general grounds-keeping. Each morning a security guard performs a routine patrol of the dam and takes a water level reading at the gatehouse standpipe. The readings and any unusual activity are reported to the Little Falls office where the information is recorded. The main purpose of the operation is to maintain a balanced water supply in all the reservoirs in the system. Thus, when Oak Ridge Reservoir is over-drafted, personnel are dispatched to Canistear to release water into the downstream impoundment.

4.2 MAINTENANCE OF DAM

Maintenance under the auspices of the Division of Water Supply is divided into two separate functioning units. As applied to the Canistear Reservoir, one unit is responsible for maintenance of the operational facilities and appurtenances while the second unit is responsible for stream and reservoir sanitation and groundkeeping. Included in the second category is maintenance of the channels and areas immediately below the dams. Discussions with personnel of the Division of Water Supply revealed that manpower shortages over the last 10 years has precluded staffing the latter category of maintenance crews which accounts for the debris-ladden outlet channel at an otherwise satisfactorily maintained dam facility. During summer months when water level in the reservoir is significantly lower, the up-stream face of the dam is inspected by division engineering personnel.

4.3 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

Although no formal warning system exists, established procedures have been delineated for alerting down-stream communities of any impending danger. The security guard who inspects the dam each day is equipped with a two-way radio. In the event of an

emergency situation he would notify the water supply facility at Charlotteburg which would dispatch repair parties to the scene of the problem as well as alert the local and State Police and the Public Works Offices of all downstream communities.

4.4 EVALUATION OF OPERATIONAL ADEQUACY

The operational and maintenance procedures applicable to this dam are satisfactory within the prescribed framework. However, only half of the maintenance procedures categorized by the Division of Water Supply are presently being implemented which will eventually result in a general deterioration of the dam's structural condition. The warning procedures in effect are considered adequate for this dam in view of the degree of development for several miles downstream.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

Based upon the Recommended Guidelines for Safety Inspection of Dams, Canistear Dam No. 1 is of intermediate size and is placed in the significant hazard category. A one-half probable maximum flood was selected as the design storm by the inspecting engineer. Inflow to the reservoir was calculated using precipitation data from Hydrometeorological Report 33 by the HEC-1 computer program, which yielded a peak of 10,832 cfs. When the inflow hydrograph was routed through the reservoir, discharge was jointly controlled by both Dam No. 1 and Canistear overflow Dam No. 2. Routing reduced the peak to 6,378 cfs while the spillway capacity at overtopping of either dam is approximately 12,345 cfs. Thus, the design storm is adequately accommodated, with a freeboard of approximately 2 feet.

b. Experience Data

There is a water stage gage at the dam site with a period of record from 1923 to the present. The maximum stage height recorded in recent years was 1086.4 on May 25 & 26, 1978. The maximum flood of record occurred in the spring of 1903. A flood stage of 1086.7 has been estimated for the 1903 storm based on the discharge from the system at that time. Otherwise, no information was available concerning the original design criteria. The outlet pipes are opened periodically, especially during periods of low flow.

c. Visual Observations

The wide spillway at Dam No. 2 has more than adequate capacity to discharge excessively large storm inflows.

d. Overtopping Potential

As there are no records of the dam being overtopped and the fact that the Dam No. 2 spillway can easily accommodate the design flood, there is little potential for overtopping.

e. Drawdown Potential

Canistear reservoir would take approximately 31 days to drawdown to El. 1035.5 through the two 48" diameter cast iron pipes.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Based upon the field inspection and available design plans, the structural stability of Dam No. 1 is adjudged to be in a good condition although the seepage adjacent to the outlet structure and at the abutments was noted. However, in view of the dams foundation, this was felt to be of a minor concern as there is little indication that seepage or piping has caused any appreciable amount of fines migrating into the coarser underlying embankment material. The minor subsidence of the riprap armor does not indicate subgrade settlement has ever been a problem at this structure. The aquaduct and gatehouse structures are aged but can readily be repaired as they remain in a sound structural condition.

b. Design and Construction Data

Design calculations and original stability analyses were not available for this dam. Based on field observations and information obtained from the owner's personnel, the dam is founded on the underlying bedrock formation. No information is available as to the base of the embankment although it is believed the embankment rests directly on bedrock. Since the surface of the bedrock contains numerous cooling fractures and joints it is possible that considerable quantities of water may pass into the underlying strata but its durability is not affected by the passage of water. The review of the record plans indicate that the intake and gate house structure were conservatively designed and in spite of their age, is believed to be in an adequate structural condition.

c. Operating Records

No records or logs are maintained at this reservoir for operations other than water consumption, water elevations, and other data associated with normal water supply operation.

d. Post Construction Changes

No major changes or additions have been made to the confining structure since its original construction. However, numerous modifications to some of the appurtenant facilities have been reported by city personnel. The most recent of these changes include the new hatchway and protective chain-link fence around the gate chamber entrance.

e. Seismic Stability

Experience indicates that dams in Zone 1 which have adequate factors of safety under static loads will be satisfactory to resist dynamic loading conditions. Additional evaluation in the future may be warranted in light of recent minor seismic activity (less than 3 on the Richter scale) along the Ramapo Fault, roughly 12 miles to the east. However, it is the opinion of the inspection team that this dam is stable under static loading conditions.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

Canistear Dam No. 1, which has stood for over 80 years, appears to be in a sound and adequate overall condition and exhibits only a few signs of its advanced age. However, because absolutely nothing is known regarding the engineered design and make-up of the embankment, its long-term structural safety remains of some concern, especially if the present stable seepage conditions display any changes in pattern. The spillway at Dam No. 2 is capable of transmitting the design discharge but no structural assessment can be made with respect to the stability of the embankments with any added loads imposed thereon. However, within the visual inspection limitations inherent in the procedures stipulated by the Phase I criteria of the Corps of Engineers, the dam is believed to be in an adequate condition if the monitoring and remedial recommendations set forth below are undertaken.

b. Adequacy of Information

While the information available to evaluate the hydraulic and hydrologic capabilities of the reservoir was adequate, the lack of design and construction data preclude a definitive evaluation of the structural stability except for what could be visually observed. However, the available data is felt to be adequate for the Phase I assessment.

c. Urgency

The remedial measures delineated herein can be undertaken in the future as part of the regular maintenance program of the Newark Division of Water Supply.

d. Necessity for Further Studies

Further studies are believed to be unnecessary under the purview of P.L. 92-367 as the Division of Water Supply has experienced engineering personnel who maintain an internal system of inspections and action plans which basically reflect, within financial limitations, the requirements mandated under the Dam Safety Act.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. Recommended Actions

1. Clean the downstream outlet of displaced riprap stone and replace same above the outlet headwall.

2. Repoint and reset all exposed stone masonry in the outlet walls.

3. Replace the antiquated valves in the gate chamber.

4. Continue to monitor and record seepage and groundwater characteristics in the vicinity of the abutment backslopes and the outlet retaining walls.

b. O&M Maintenance and Procedures

Although present procedures are being diligently pursued in a competent, workmanlike manner, it is suggested that Division of Water Supply personnel employed at the reservoir receive additional training in the safety inspection of dams. It is further recommended that after training, these same personnel conduct the regularly schedule inspections.

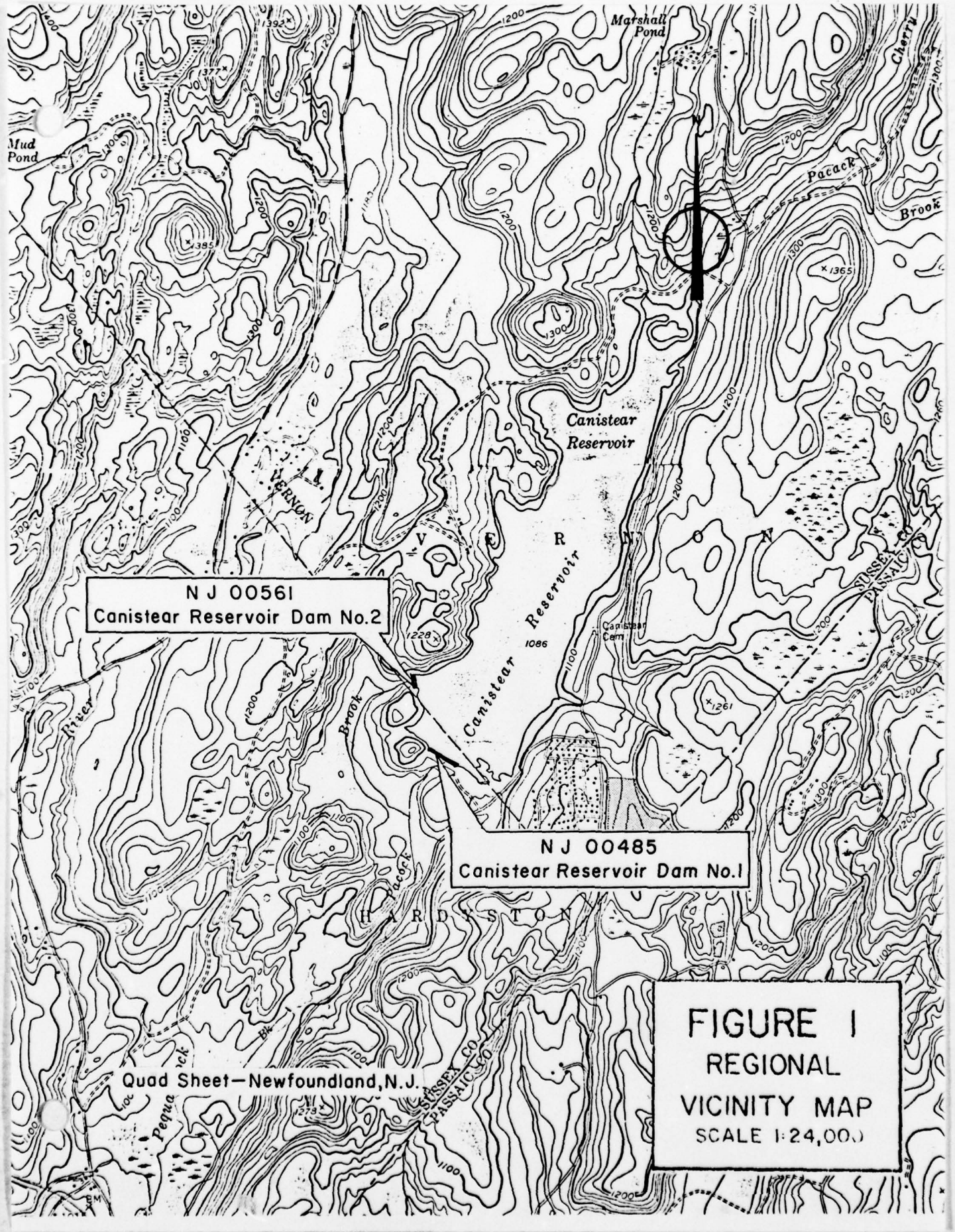
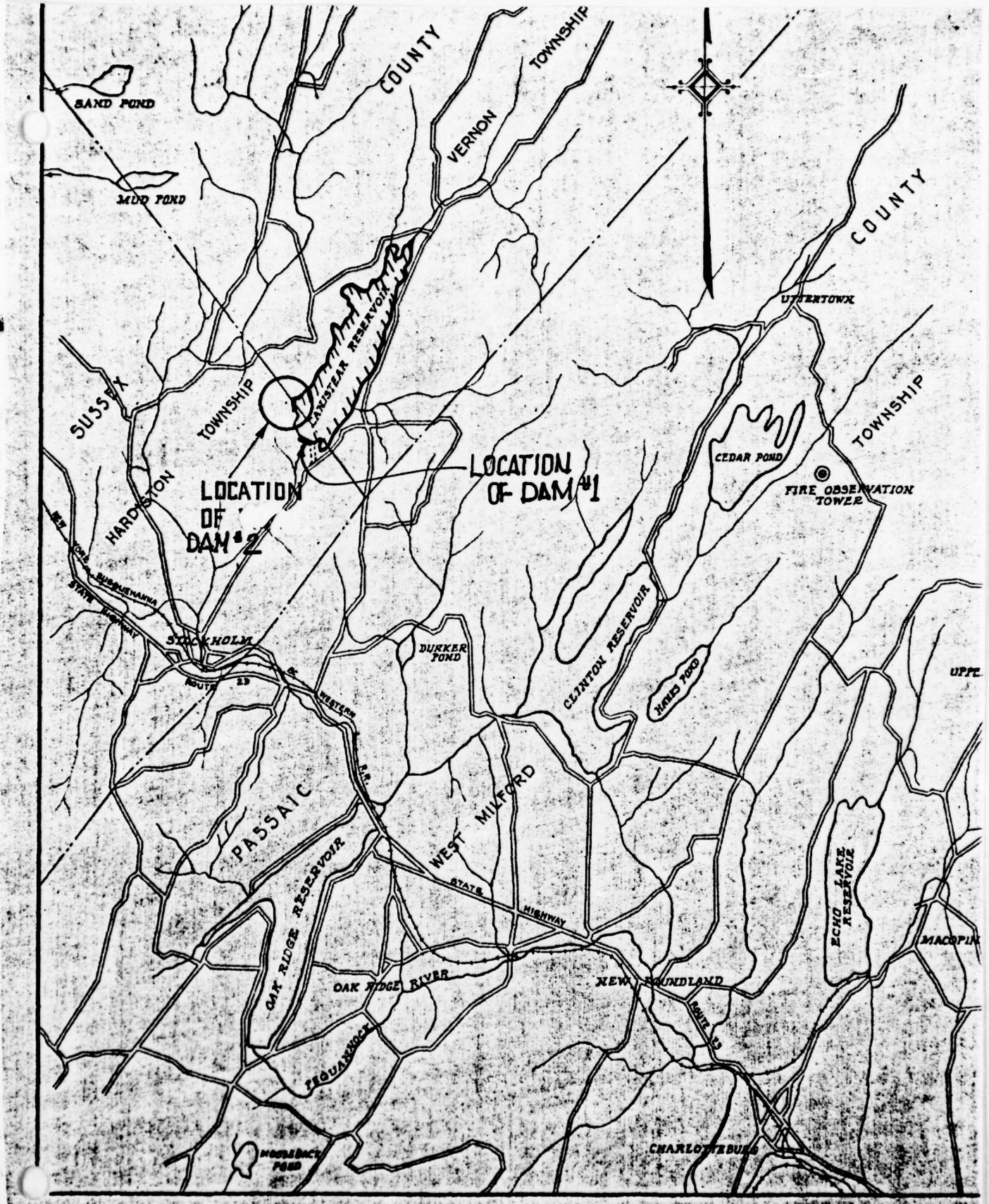


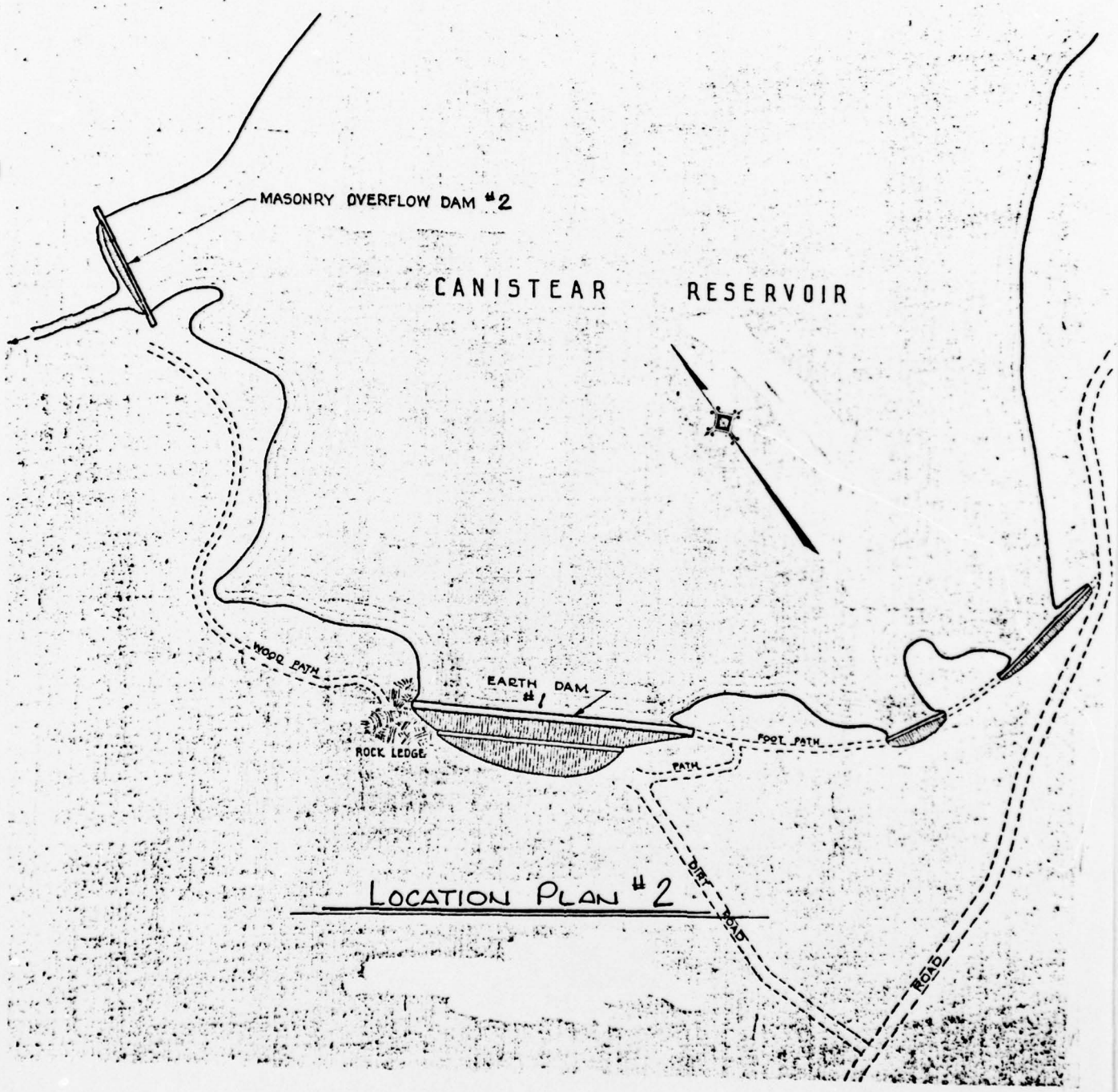
FIGURE 1
REGIONAL
VICINITY MAP
SCALE 1:24,000



LOCATION PLAN #1

SCALE: 1" = 1 MILE

Fig. 2



LOCATION PLAN #2

FIGURE 3

Section of Canistear Dam No.1

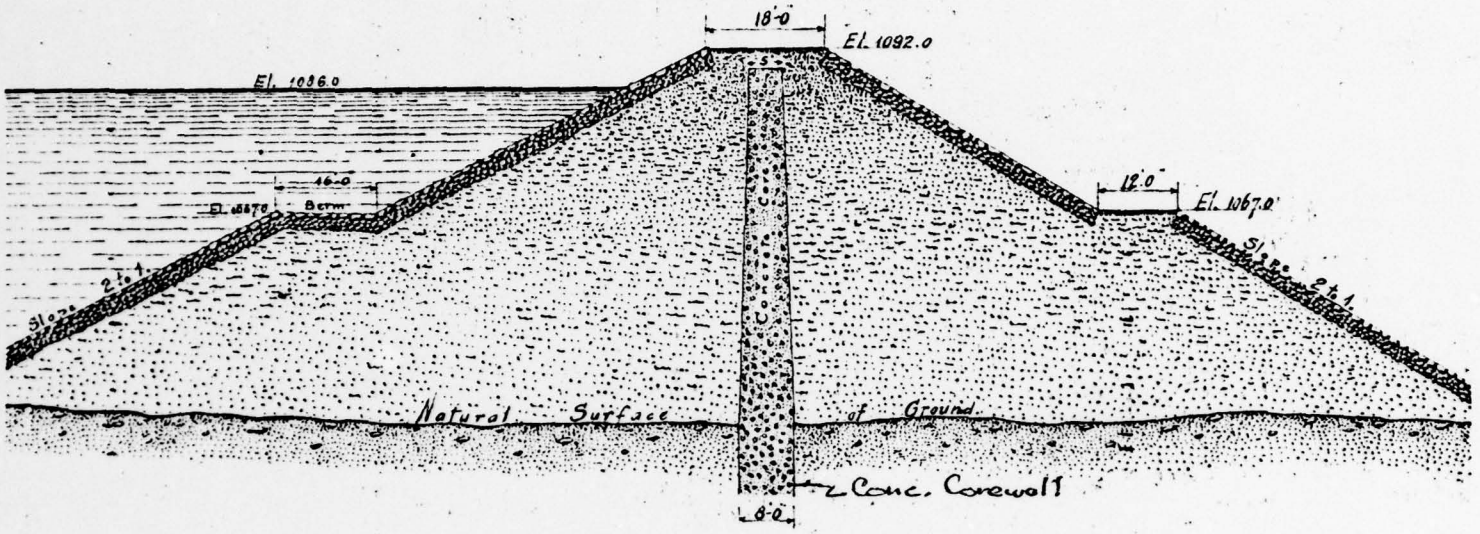


FIGURE 4

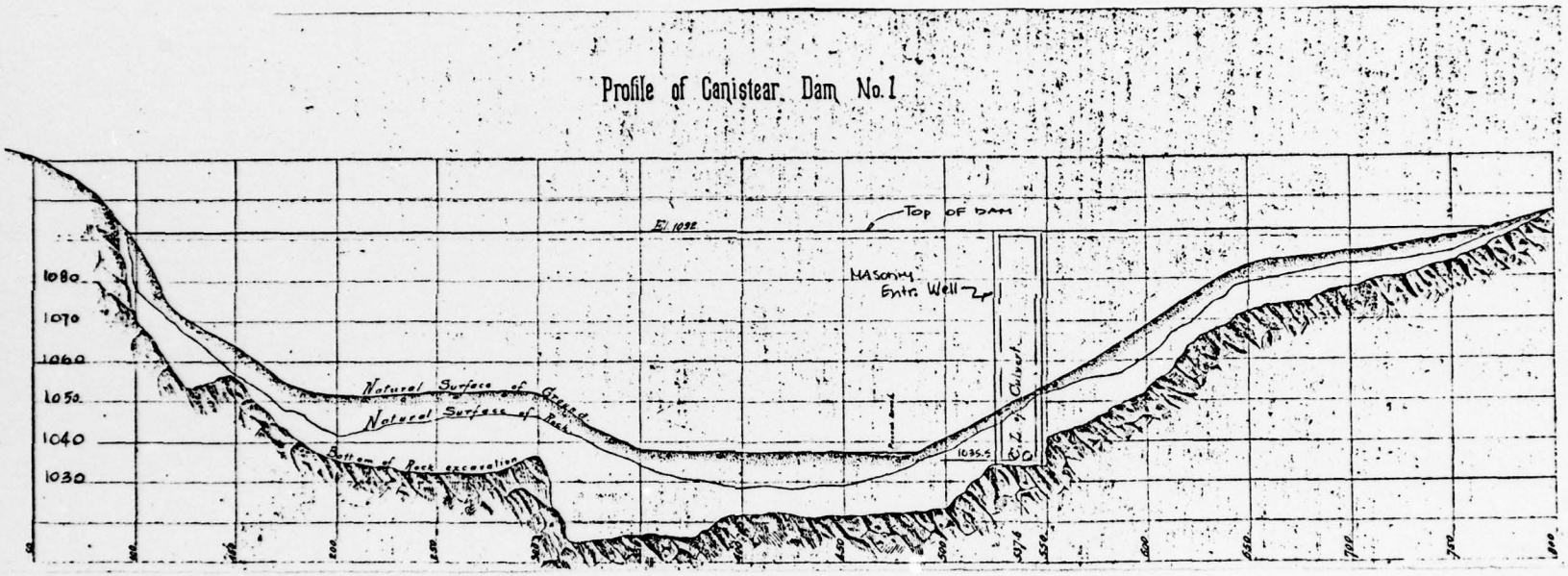
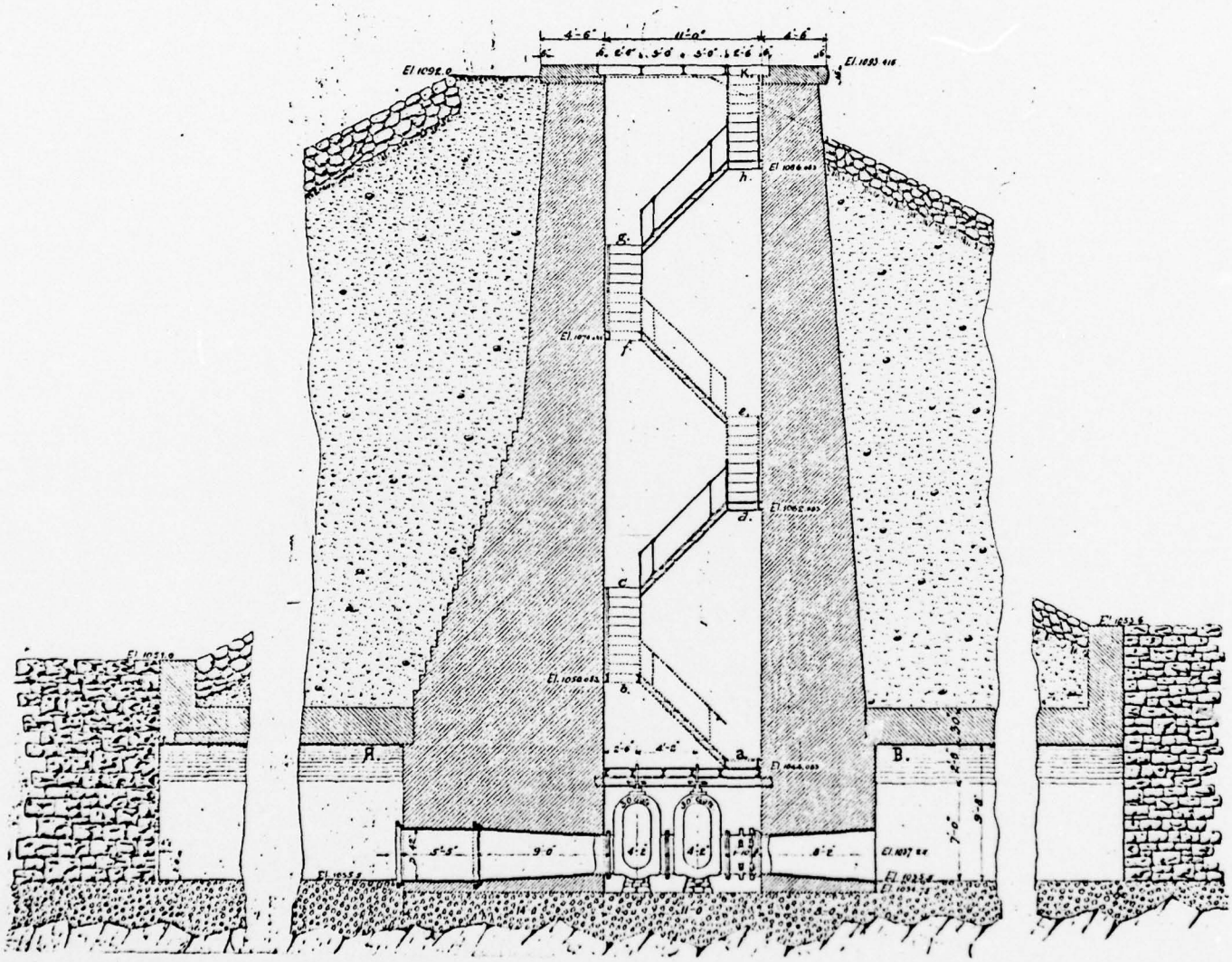

Profile of Canistear Dam No. 1
El. 1092
Top of Dam
Masonry
Entr. Well
Natural Surface of Ground
Natural Surface of Rock
Bottom of Rock excavation
Culvert
1035.5
1080
1070
1060
1050
1040
1030

FIGURE 5



Dam No. 1
FIGURE 6

Check List
Visual Inspection
Phase 1

Name Dam Canistear Res #1 County Sussex State N.J. Coordinators NJDEP

Date(s) Inspection 5/10/79 Weather Clear Temperature 90°

Pool Elevation at Time of Inspection 1086.3 M.S.L. Tailwater at Time of Inspection None M.S.L.

Inspection Personnel:

K. Jolls LBA — Jim Conley (Newark W.S.) — Mark Carter (Raamot)

T. Chapter LBA — Ken Greenfield (Raamot)

John Moyle (NJDEP)

T. Chapter Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None noted	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None noted	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Behind left wingwall at end of outlet structure.	Eroded area should be refilled and regraded.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Good - Road on left half of crest to valve chamber.	
RIPRAP FAILURES	17' wide swath from berm to top of outlet structure displaced into structure - Probably vandalism. Riprap on upstream face doesn't extend as high as elevation shown on plans (possible settlement, some unevenness of stone on front face).	Outlet structure should be cleaned out. Riprap should be replaced and realigned where necessary.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
	Several small pine trees (< 10' tall) growing on backslope. Very light brush growing on backslope berm. Small brush on upstream face.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good - Embankment extends to bedrock at both ends. No sign of seepage or erosion at either junction although swales exist at both ends.	
ANY NOTICEABLE SEEPAGE	Slightly damp below berm on left side. Wet in 3 areas downstream of toe below right side of dam.	
STAFF GAGE AND RECORDER	Water level standpipe inside gate chamber.	
DRAINS		

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Spalling - cracking of joints, efflorescence heavy inside conduit. Blocks working loose at base of both wingwalls and piers.	Heavy seepage from ceiling, left wing wall starting 5.5' from top. Light seepage at base of right wingwall.
INTAKE STRUCTURE	Not visible	
OUTLET STRUCTURE	Heavy efflorescence - Loaded with riprap from above open cracks between masonry spalling behind.	Stilling structure deteriorated badly - step or log missing. Constricting concrete bracket and foot slot of "stop log" structure at end of channel completely disintegrated.
OUTLET CHANNEL	Loaded with riprap rubble from the backslope 6' high bedrock outcrop 3' wide 6' long through left wingwall.	There should be a cyclone fence around the edge of the structure to prevent accidental falls into the 18 foot deep outlet.
EMERGENCY GATE	2 - 30" gates - 4 valves - 1 wheel and stem missing off left pipe.	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	Standpipe located in gatehouse for water elevations of reservoir.	Normal stage is 1086. Maximum stage recorded was 1086.4 in May, 1978.

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Heavily wooded - undeveloped - usually bedrock outcrops near waterline.	
SEDIMENTATION	Unknown - however, heavy accumulation at center of reservoir must be assumed due to the antiquity of the lake.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Stone lined natural channel along original course of Pacack Brook. Narrow incised channel in wider valley which is now heavily wooded.	
SLOPES	Relatively steep becoming flat at flood plain of Pequannock River.	
APPROXIMATE NO. OF HOMES AND POPULATION	No homes or development between dam and the Pequannock River about a mile downstream. Numerous homes and businesses located on the edge of the flood plain in Stockholm.	Backwater caused by a downstream constriction of the Pequannock River could flood portions of Stockholm.

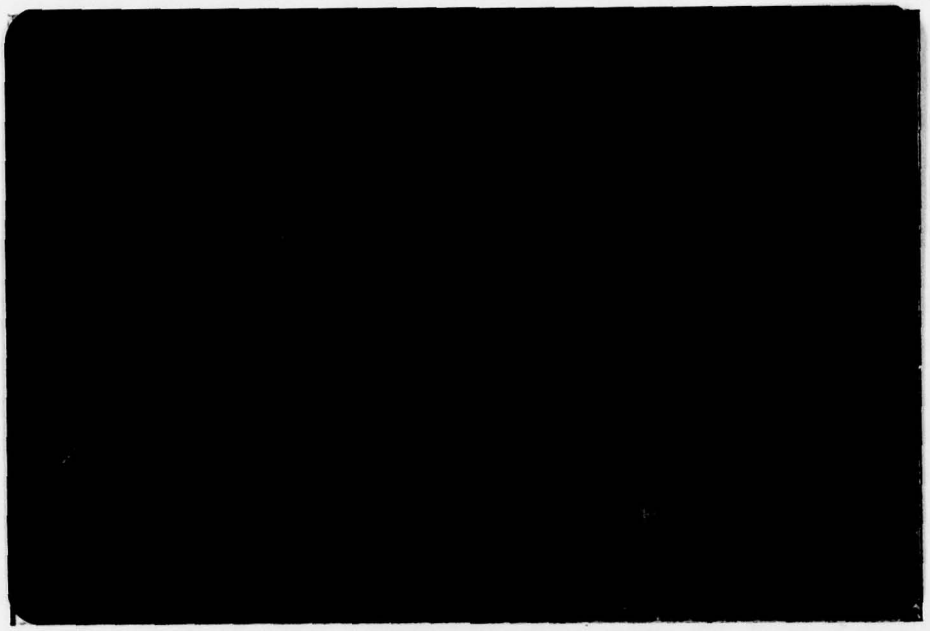
CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Available - City of Newark, Div. of Water Supply, Little Falls, N.J.
REGIONAL VICINITY MAP	Available - U.S.G.S. Quadrangle - Newfoundland, N.J.
CONSTRUCTION HISTORY	Unavailable
TYPICAL SECTIONS OF DAM	Available - City of Newark - D.W.S.
HYDROLOGIC/HYDRAULIC DATA	Unavailable
OUTLETS - PLAN	Available - City of Newark - D.W.S.
- DETAILS	" " " "
-CONSTRAINTS	Not Available
-DISCHARGE RATINGS	" "
RAINFALL/RESERVOIR RECORDS	Available - City of Newark - D.W.S.

ITEM	REMARKS
SPILLWAY PLAN	N/A
SECTIONS	
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	Available - City of Newark - D.W.S.

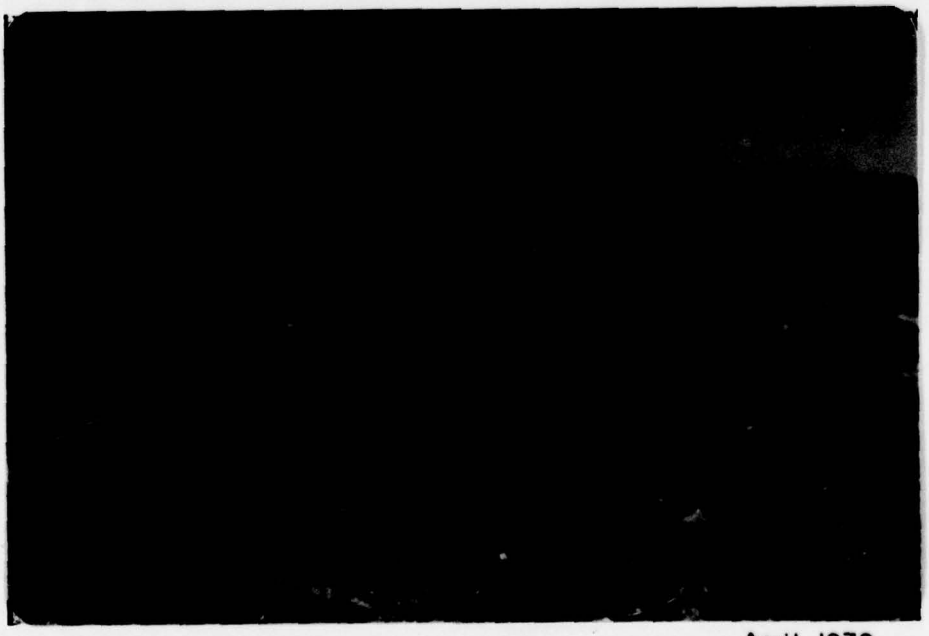
ITEM	REMARKS
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	Available - State Geologic Map - Rutgers Engineering Soil Survey
DESIGN COMPUTATIONS	Not Available
HYDROLOGY & HYDRAULICS	" "
DAM STABILITY	" "
SEEPAGE STUDIES	" "
MATERIALS INVESTIGATIONS	Not Available
BORING RECORDS	" "
LABORATORY	" "
FIELD	" "
POST-CONSTRUCTION SURVEYS OF DAM	Not Available
BORROW SOURCES	Not Available

ITEM	REMARKS
MONITORING SYSTEMS	Daily inspections by security personnel
MODIFICATIONS	Available - City of Newark - D.W.S.
HIGH POOL RECORDS	Available " " "
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Not Available
PRIOR ACCIDENTS OR FAILURE OF DAM	None
DESCRIPTION	N/A
REPORTS	N/A
MAINTENANCE	Available - City of Newark - D.W.S.
OPERATION	" " " "
RECORDS	" " " "



April, 1979

View of Crest Looking Northwest



April, 1979

View of Backsl

May, 1979

View of Outlet Structure

May, 1979

View of Discharge Channel

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 5.32 sq. mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1,086 (7,400± acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N/A

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1,092 (9,315 acre-feet)

CREST:

a. Elevation
b. Type
c. Width
d. Length
e. Location Spillover
f. Number and Type of Gates

OUTLET WORKS: Concrete valve chamber (gate house) inside dam. Two 42" dia. C.I. low level drains with four 30" in gate house

a. Type
b. Location 537 feet from right abutment
c. Entrance inverts 1035.5
d. Exit inverts 1035.5
e. Emergency draindown facilities

HYDROMETEOROLOGICAL GAGES:

a. Type Reservoir water level standpipe
b. Location Gatehouse
c. Records Not monitored systematically

MAXIMUM NON-DAMAGING DISCHARGE: 12,345 cfs

BY D. J. M. DATE 5-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A1 OF

CHKD. BY DATE CANISTEAR RESERVOIR DAMS 1 & 2 PROJECT C.234

SUBJECT

Time of concentration :

length of longest watercourse ≈ 1.5 miles = 7920 ft.

$\Delta H \approx 1140 - 1086 = 54$ ft.

$$\therefore \text{Slope} = \frac{54}{7920} = 0.7\ \%$$

from U.S. Navy Tech. Publication TP - PW - 5
take average velocity = 2.0 ft s^{-1}

$$\therefore t_c = \frac{7920}{2 \times 60} = 66 \text{ minutes}$$

By California Culverts Equation :

$$t_c = \left(\frac{11.9 \times 1.5^3}{54}\right)^{0.385} = 0.89 \text{ hours} = 54 \text{ minutes}$$

By Kirpich's formula :

$$t_c = 0.00013 \times \frac{7920^{0.77}}{0.007^{0.385}} = 0.88 \text{ hours}$$

$$= 53 \text{ minutes}$$

use t_c = 1 hour and use 1/4 hour increments

$$t_p = \frac{0.25}{2} + 0.6 \times 1 = 0.73 \text{ hours}$$

$$Q_p = \frac{484 \times 532}{0.73} = 3527 \text{ cfs}$$

BY D.J.M. DATE 5-79 | **LOUIS BERGER & ASSOCIATES INC.** | SHEET NO. A2 OF

CHKD. BY ____ DATE ____ | CANISTEAR RESERVOIR DAMS 1 & 2 | PROJECT C234

SUBJECT UNITGRAPH FOR HEC-1 PROGRAM

T hours	T/Tp	Dimensionless ordinate (DO)	Q (cfs) = Qp × DO
0.25	0.34	0.20	705
0.50	0.68	0.73	2575
0.75	1.03	0.998	3520
1.00	1.37	0.777	2740
1.25	1.71	0.47	1658
1.50	2.05	0.29	1023
1.75	2.40	0.18	635
2.00	2.74	0.107	377
2.25	3.08	0.067	236
2.50	3.42	0.04	141
2.75	3.77	0.025	88
3.00	4.11	0.016	56

Check unitgraph $\Sigma Q = 13754$

$$\frac{13754 \times 3600 \times 12}{5.32 \times 5280^2 \times 4} = 1.00155'' - \text{O.K.}$$

BY. D. J. M. DATE 5-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A3 OF.
CHKD. BY. DATE CANISTEAR RESERVOIR DAMS 1 & 2 PROJECT G-234
SUBJECT

PRECIPITATION DATA :

from Hydrometeorological Report # 33, for 200 square miles and 24 hours (in inches)

PMP in inches = 22.5

Maximum 6 hour percentage = 113 % = 25.43 inches

Maximum 12 hour percentage = 123 % = 27.68 inches

Maximum 24 hour percentage = 132 % = 29.70 inches

BY D.J.M. DATE 5-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A4 OF
CHKD. BY DATE CANISTEAR RESERVOIR DAMS 1 & 2 PROJECT C-234
SUBJECT

Spillway discharge capacity :

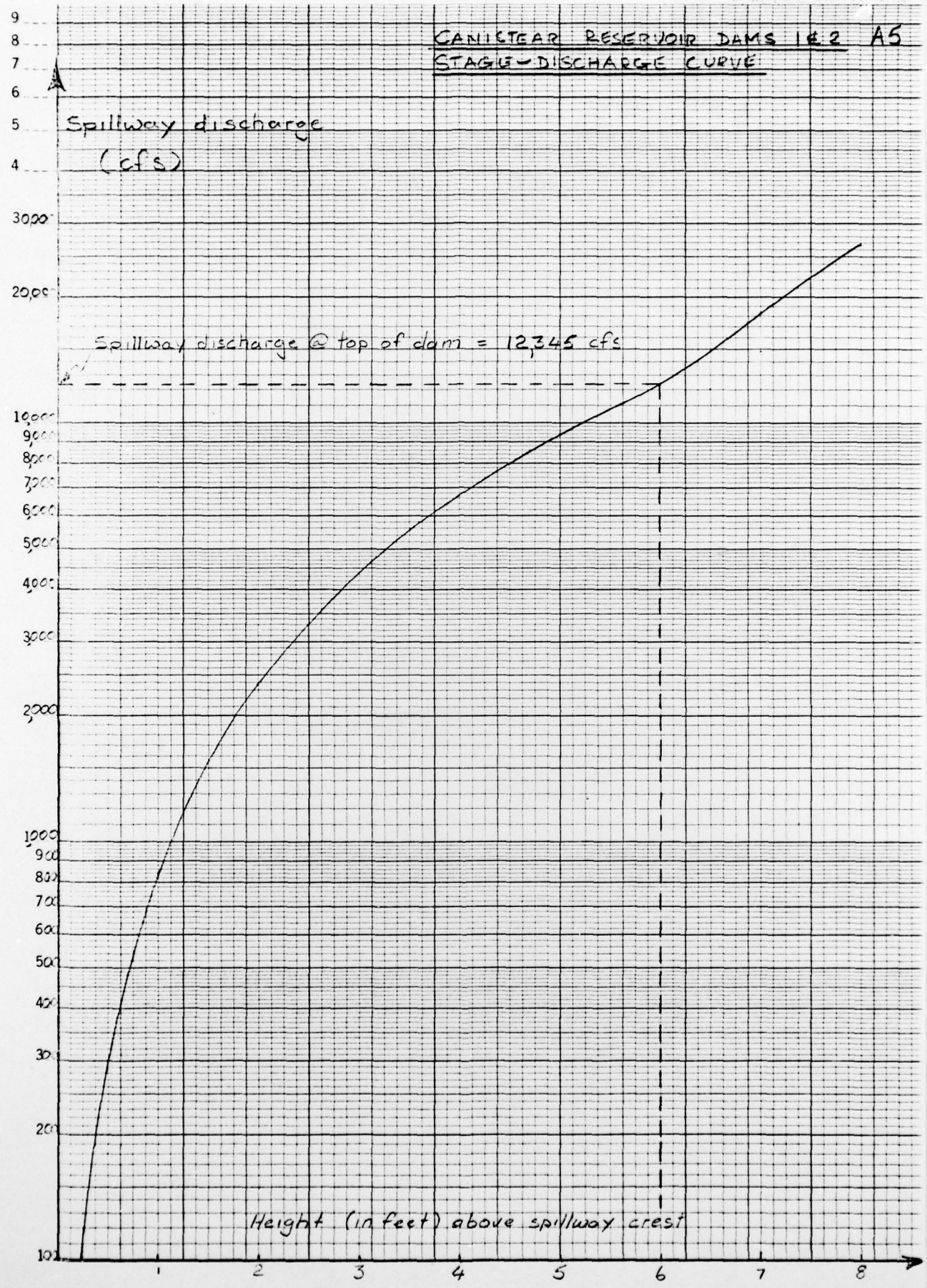
Over spillway crest Dam # 2 L = 280'				Over dams 1&2 Combined L: 680+330 = 1010'			Σ Q (cfs)
Elev.	H	C	Q	H	C	Q	
1086	0	0	0				0
1087	1	3.0	840				840
1088	2	3.0	2,375				2,375
1089	3	3.0	4,365				4,365
1090	4	3.0	6,720				6,720
1091	5	3.0	9,391				9,391
1092	6	3.0	12,345				12,345
1092.5 *	6.5	3.0	13,920	0.5	2.7	964	14,884
1093 *	7	3.0	15,557	1.0	2.7	2727	18,284
1094 *	8	3.0	19,267	2.0	2.7	7713	26,720

* Indicates overtopping of the two dams

The above calculations are based on the fact that the two dams impound the same reservoir. Dam # 1 has two low level outlets which have been neglected in the above calculations, as there is no gaurantee that they will be open under flood conditions. Therefore the spillway discharge is for dam # 2 only.

CANISTEAR RESERVOIR DAMS 1 & 2 A5

STAGE-DISCHARGE CURVE



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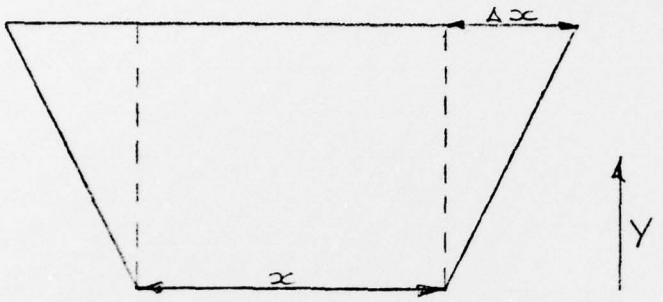
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO MADE IN U.S.A.

BY D J M DATE 5-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A6 OF

CHKD. BY DATE CANISTEAR RESERVOIR DAMS 1&2 PROJECT C234

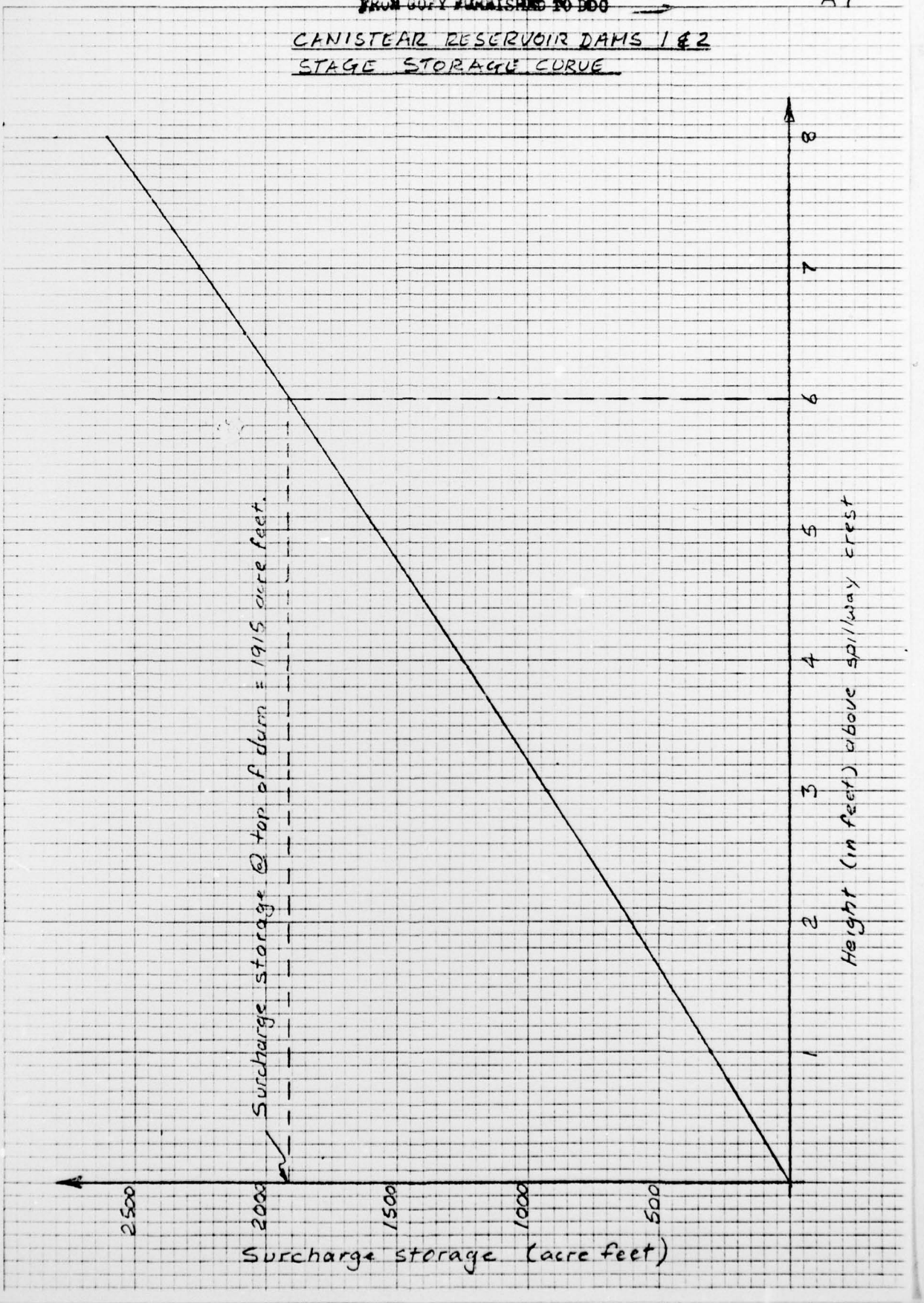
SUBJECT

SURCHARGE STORAGE :



Increment in Volume $\Delta V = (x + \Delta x)Y$

Elev	H (ft)	SURCHARGE STORAGE (Ac. ft.)
1086	0	0
1087	1	305
1088	2	615
1089	3	932
1090	4	1254
1091	5	1581
1092	6	1915
1092.5	6.5	2084
1093	7	2254
1094	8	2599



BY D.J.M. DATE 8-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A8 OF

CHKD. BY ..... DATE ..... CANISTEAR RESERVOIR PROJECT C234

SUBJECT Approximate drawdown calculations

Take h from El. 1039 to El. 1086 = 47'
drawdown in 4 equal stages
assume no inflow to reservoir
Volume = 7400 acre feet

Stage 1) $H = 41.13$ $Q = 191$ cfs

$$\text{time} = \frac{7400 \times 43560}{191 \times 4 \times 3600} = 117.2 \text{ hours}$$

Stage 2) $H = 29.38$ $Q = 162$ cfs

$$\text{time} = \frac{7400 \times 43560}{162 \times 4 \times 3600} = 138 \text{ hours}$$

Stage 3) $H = 17.63$ $Q = 125$ cfs

$$\text{time} = \frac{7400 \times 43560}{125 \times 4 \times 3600} = 179 \text{ hours}$$

Stage 4) $H = 5.88$ $Q = 72$ cfs

$$\text{time} = \frac{7400 \times 43560}{72 \times 4 \times 3600} = 311 \text{ hours}$$

$\Sigma = (311 + 179 + 138 + 117)/24 = 31.04$ Say 31 days

Q calculated by following formula

$$Q = \sqrt{\frac{100\ H_T}{\left(\frac{2.5204\,(1+K_e)}{D^4} + \frac{466.18\,n^2 L}{D^{16/3}}\right)}}$$

Where H_T = head $L = 250$

$n = 0.02$

$K_e = 0.5$ $D = 2.5'$

BY D.J.M. DATE 5-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A9 OF.
CHKD. BY DATE CANISTEAR RESERVOIR DAM # 1 PROJECT C234
SUBJECT

GENERAL SUMMARY OF APPENDIX :

length of dam = 680'
Effective length of spillway = NA @ El.

Total spillway capacity @ top of dam = 0 cfs

Surcharge storage @ top of dam = 1915 ac.ft.
Storage @ normal pool = 7400 " "

∴ Total storage @ top of dam = 9315 ac.ft.

Lake area @ normal pool = 302 acres
Lake area @ top of dam = 336 acres

Dam No. 1 has no spillway thus in the routing computations the spillway discharge is that of Dam # 2

CANNISTEAR DAMS 1&2 INSPECTION
BY LINDA J. BAINES
JUNE 14 1979

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	0	15	0	0	0	0	0	0	0

JOPER	NWT
3	0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	-1	5.32	0.0	5.32	0.0	0.500	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	22.50	113.00	123.00	132.00	0.0	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.776

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.50	0.10	0.0	0.0

GIVEN UNIT GRAPH, NUPGG= 12

705. 2573. 3520. 2740. 1658. 1023. 635. 377. 236. 141.
88. 56.

UNIT GRAPH TOTALS 13752. CFS OR 1.00 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 0.0 QRCSN= 0.0 RTIOR= 1.00

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.03	0.00	0.
2	0.03	0.00	0.
3	0.03	0.00	0.
4	0.03	0.00	0.
5	0.03	0.00	0.
6	0.03	0.00	0.
7	0.03	0.00	0.
8	0.03	0.00	0.
9	0.03	0.00	0.
10	0.03	0.00	0.
11	0.03	0.00	0.
12	0.03	0.00	0.

BY L.B. DATE 6-79
CHKD. BY DATE
SUBJECT CANNISTEAR RESERVOIR TF 1&2

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A10 OF
PROJECT C-234

BY L.B. DATE 6-79
CHKD. BY ____ DATE ____
SUBJECT ____

LOUIS BERGER & ASSOCIATES INC.

CANISTEAR RESERVOIR #182

SHEET NO. A11 OF
PROJECT G-234

13	0.03	0.00	0.
14	0.03	0.00	0.
15	0.03	0.00	0.
16	0.03	0.00	0.
17	0.03	0.00	0.
18	0.03	0.00	0.
19	0.03	0.00	0.
20	0.03	0.00	1.
21	0.03	0.00	4.
22	0.03	0.00	8.
23	0.03	0.00	11.
24	0.03	0.00	13.
25	0.07	0.05	47.
26	0.07	0.05	168.
27	0.07	0.05	332.
28	0.07	0.05	460.
29	0.07	0.05	538.
30	0.07	0.05	586.
31	0.07	0.05	615.
32	0.07	0.05	633.
33	0.07	0.05	644.
34	0.07	0.05	650.
35	0.07	0.05	654.
36	0.07	0.05	657.
37	0.07	0.05	657.
38	0.07	0.05	657.
39	0.07	0.05	657.
40	0.07	0.05	657.
41	0.07	0.05	657.
42	0.07	0.05	657.
43	0.07	0.05	657.
44	0.07	0.05	657.
45	0.07	0.05	657.
46	0.07	0.05	657.
47	0.07	0.05	657.
48	0.07	0.05	657.
49	0.49	0.47	954.
50	0.49	0.47	2036.
51	0.49	0.47	3517.
52	0.49	0.47	4669.
53	0.59	0.57	5436.
54	0.59	0.57	6121.
55	0.59	0.57	6735.
56	0.59	0.57	7164.
57	0.74	0.72	7531.
58	0.74	0.72	8072.
59	0.74	0.72	8693.
60	0.74	0.72	9160.
61	1.88	1.85	10228.
62	1.88	1.85	13314.
63	1.88	1.85	17411.
64	1.88	1.85	20582.
65	0.69	0.67	21664.
66	0.69	0.67	19799.
67	0.69	0.67	16264.
68	0.69	0.67	13555.
69	0.54	0.52	11755.
70	0.54	0.52	10323.
71	0.54	0.52	9150.
72	0.54	0.52	8361.
73	0.04	0.01	7481.

74	0.04	0.01	5868.
75	0.04	0.01	3897.
76	0.04	0.01	2395.
77	0.04	0.01	1526.
78	0.04	0.01	990.
79	0.04	0.01	657.
80	0.04	0.01	459.
81	0.04	0.01	340.
82	0.04	0.01	269.
83	0.04	0.01	225.
84	0.04	0.01	197.
85	0.04	0.01	197.
86	0.04	0.01	197.
87	0.04	0.01	197.
88	0.04	0.01	197.
89	0.04	0.01	197.
90	0.04	0.01	197.
91	0.04	0.01	197.
92	0.04	0.01	197.
93	0.04	0.01	197.
94	0.04	0.01	197.
95	0.04	0.01	197.
96	0.04	0.01	197.
97	0.0	0.0	187.
98	0.0	0.0	150.
99	0.0	0.0	99.
100	0.0	0.0	60.
SUM	23.08	20.64	283663.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	21664.	10556.	2955.	2837.	283661.
INCHES		18.46	20.67	20.67	20.67
AC-FT		5237.	5864.	5864.	5864.

RUNOFF MULTIPLIED BY 0.50

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2.	4.	6.	7.	24.	84.	166.	230.	269.	293.
306.	316.	322.	325.	327.	329.	329.	329.	329.	329.
329.	329.	329.	329.	329.	329.	329.	329.	477.	1018.
1758.	2335.	2718.	3060.	3368.	3582.	3766.	4036.	4347.	4580.
5114.	6657.	8706.	10291.	10832.	9899.	8182.	6778.	5878.	5162.
4579.	4181.	3741.	2934.	1949.	1198.	763.	495.	329.	229.
170.	135.	112.	98.	98.	98.	98.	98.	98.	98.
98.	98.	98.	98.	98.	98.	93.	75.	50.	30.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	10832.	5278.	1477.	1418.	141830.
INCHES		9.23	10.33	10.33	10.33
AC-FT		2618.	2932.	2932.	2932.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
11	1	0	0	0	0	1

BY LJB DATE 6-74 LOUIS BERGER & ASSOCIATES INC. SHEET NO. A13 OF

CHKD. BY _____ DATE _____ CANISTEAR RESERVOIR NO. 1 & 2 PROJECT C-234

SUBJECT _____

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.0	0.0	0.0	0.

STORAGE=	0.	305.	615.	932.	1254.	1581.	1915.	2084.	2254.	2595.
OUTFLOW=	0.	840.	2375.	4365.	6720.	9391.	12345.	14884.	18284.	26720.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	0.	0.
2	0.	0.	0.
3	0.	0.	0.
4	0.	0.	0.
5	0.	0.	0.
6	0.	0.	0.
7	0.	0.	0.
8	0.	0.	0.
9	0.	0.	0.
10	0.	0.	0.
11	0.	0.	0.
12	0.	0.	0.
13	0.	0.	0.
14	0.	0.	0.
15	0.	0.	0.
16	0.	0.	0.
17	0.	0.	0.
18	0.	0.	0.
19	0.	0.	0.
20	0.	0.	0.
21	0.	1.	0.
22	0.	3.	0.
23	0.	5.	0.
24	0.	6.	1.
25	1.	15.	2.
26	2.	54.	4.
27	4.	125.	11.
28	8.	198.	22.
29	12.	250.	34.
30	17.	281.	48.
31	22.	300.	62.
32	27.	312.	76.
33	32.	319.	89.
34	37.	324.	102.
35	42.	326.	114.
36	46.	328.	126.
37	50.	329.	137.
38	54.	329.	148.

LOUIS BERGER & ASSOCIATES INC.

CANISTEAR RESERVOIR #122

39	57.	329.	158.
40	61.	329.	167.
41	64.	329.	176.
42	67.	329.	185.
43	70.	329.	193.
44	73.	329.	200.
45	75.	329.	207.
46	78.	329.	214.
47	80.	329.	220.
48	82.	329.	226.
49	86.	403.	236.
50	96.	747.	264.
51	119.	1388.	327.
52	153.	2046.	422.
53	195.	2526.	538.
54	243.	2889.	668.
55	294.	3214.	809.
56	346.	3475.	1045.
57	398.	3674.	1301.
58	449.	3901.	1554.
59	501.	4191.	1811.
60	553.	4463.	2069.
61	608.	4847.	2339.
62	677.	5886.	2762.
63	772.	7681.	3361.
64	891.	9498.	4109.
65	1016.	10562.	4976.
66	1119.	10366.	5733.
67	1183.	9041.	6198.
68	1207.	7480.	6378.
69	1206.	6328.	6371.
70	1190.	5520.	6251.
71	1163.	4868.	6057.
72	1131.	4378.	5821.
73	1095.	3961.	5560.
74	1053.	3337.	5248.
75	999.	2441.	4853.
76	936.	1573.	4392.
77	870.	980.	3973.
78	805.	629.	3566.
79	743.	412.	3182.
80	687.	279.	2828.
81	636.	200.	2508.
82	590.	152.	2252.
83	548.	124.	2045.
84	510.	105.	1856.
85	476.	98.	1685.
86	444.	98.	1531.
87	416.	98.	1391.
88	391.	98.	1265.
89	368.	98.	1152.
90	347.	98.	1049.
91	329.	98.	957.
92	312.	98.	873.
93	296.	98.	816.
94	282.	98.	776.
95	268.	98.	739.
96	255.	98.	703.
97	243.	96.	670.
98	231.	84.	637.
99	220.	62.	605.
100	208.	40.	574.
SUM			132011.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6378.	4285.	1375.	1320.	132011.
INCHES		7.49	9.62	9.62	9.62
AC-FT		2126.	2729.	2729.	2729.

RUNOFF SUMMARY. AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	10832.	5278.	1477.	1418.	5.32
ROUTED TO	11	6378.	4285.	1375.	1320.	5.32